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AMENDMENTS TO THE DRAWINGS:

The attached new sheet of drawings includes new Figure 8. In new Figure 8, a roller including the crownings described in the Application on page 12, lines 1-7 is shown. No new matter has been added.

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REMARKS

Claims 1-20 are all the claims presently pending in the application. Claims 1, 7-8, 15-16, 18 and 20 have been amended to more particularly define the invention.

It is noted that the claim amendments made herein or later are not made to distinguish the invention over the prior art or narrow the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein or later should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Applicant gratefully acknowledges the Examiner's indication that claims 10-14 and 17 have been allowed and that claim 16 would be allowable if rewritten or amended to overcome the rejection under 35 U.S.C. §112, second paragraph, set forth below. However, Applicant respectfully submits that all the claims presently pending are allowable.

Claim 18 has been objected to because of informalities. Claims 1-9, 15 and 20 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Claims 7, 8 and 16 stand rejected under 35 U.S.C. §112, second paragraph, as being as being indefinite.

Regarding the prior art rejections, claim 18 stands rejected under 35 U.S.C. §102(b) as being anticipated by Woolgar (U.S. Patent No. 1,602,472). Claim 19 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Woolgar.

These rejections are respectfully traversed in the following discussion.

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I. THE CLAIMED INVENTION

An exemplary aspect of the invention, as recited in claim 1, is directed to a cross shaft including a trunnion, a roller bearing externally provided at the trunnion, and a recess formed at a distal end face of the trunnion. A bottom region of the recess comprises a spherical shape and a size of an opening region of the recess except the bottom region gradually increases toward an opening end of the recess.

Another aspect of the invention, as recited in claim 18, is directed to a cross shaft including a trunnion, a roller bearing externally provided on the trunnion comprising rollers arranged in a plurality of rows in parallel in an axial direction of the trunnion, and a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion. The plurality of bearing rolling faces are reduced in diameter from a root of the trunnion toward a distal end of the trunnion, and a radial clearance between the rollers and the rolling faces is increased for the plurality of rows from the root of the trunnion toward the distal end of the trunnion. The diameters of the rollers comprising the roller bearing are the same.

In conventional trunnion structures, there has been a tendency for the rollers to break down when the contact face pressure of the rollers at the distal end of the trunnion is increased at a time of torque transmission under high load. To avoid such a break down, it is known to arrange the rollers in a plurality of rows in an axial direction along the trunnion, where the diameters of the rollers in respective rows are made successively larger toward the root of the trunnion in order to substantially equalize the contact face pressure at the time of torque transmission. (See Application at page 1, lines 13-25)

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However, the higher the load during torque transmission, the larger the differences must be made between the diameters of rollers in the respective rows. As such, since the radial clearances of the rollers with respect to the trunnion must be made larger, the rollers become liable to skew. (See Application at page 2, lines 1-8)

It has also been proposed to provide a recess substantially in the shape of a frustum of a cone at the distal end of the trunnion to reduce the bending rigidity of the trunnion. In this manner, the trunnion can be flexed at the time of torque transmission, thereby reducing deflection of bending stress to the root of the trunnion. (See Application at page 2, lines 10-16) However, there are concerns that when a large recess is formed, rigidity of the trunnion with respect to the applied load may be insufficient. (See Application at page 2, lines 18-22)

The claimed invention, on the other hand, provides a trunnion and a recess formed at a distal end face of the trunnion, wherein a bottom region of the recess comprises a spherical shape and a size of an opening region of the recess except the bottom region gradually increases toward an opening end of the recess. These features, amongst others, enable the trunnion to be flexed in its entirety from the root of the trunnion. When flexed in such a manner, the rollers are evenly brought into contact with their respective rolling faces and, as such, the concentration of the contact face pressure to the edges of the rollers is restrained. In this manner, the exfoliation life and bending strength of the rolling faces of the trunnion can be enhanced. (See Application at page 10, lines 3-14)

The claimed invention also provides a trunnion having a plurality of bearing rolling faces reduced in diameter from a root of the trunnion toward a distal end of the trunnion, and a radial clearance between the rollers and the rolling faces increased for each of the plurality

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of rows from the root of the trunnion toward the distal end of the trunnion, wherein the diameters of the rollers comprising the roller bearing are the same. By forming the rolling faces in this manner, it is possible to equally distribute the contact face pressure exerted on the rollers during torque transmission, while preventing the rollers from skewing. (See Application at page 7, lines 13-17)

II. THE 35 USC § 112, FIRST PARAGRAPH REJECTION

Claims 1-9, 15 and 20 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Claim 1 has been amended to recite "an opening region of the recess except the bottom region is set to be gradually larger toward an opening end edge of the recess." Support for this limitation is found in the Application at page 7, lines 24-25 and page 8, lines 1-3. Additionally, in light of the amendment to claim 1, claims 15 and 20 have been also been amended to address the Examiner's rejection.

In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

III. THE 35 USC § 112, SECOND PARAGRAPH REJECTION

Claims 7, 8 and 16 stand rejected under 35 U.S.C. §112, second paragraph, as being as being indefinite. Claims 7, 8 and 16 have been amended, above, to overcome this rejection. Specifically, the informalities cited by the Examiner have been addressed.

In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

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IV. THE WOOLGAR REFERENCE

The Examiner alleges that the invention of claim 18 is anticipated by Woolgar. The Examiner also alleges that the invention of dependent claim 19 is unpatentable over Woolgar. However, Applicant respectfully submits that the reference does not teach or suggest each and every element of the claims 18 and 19.

However, Woolgar does not disclose or suggest "a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion reduced in diameter from a root of the trunnion toward a distal end of the trunnion, wherein a radial clearance between the rollers and the rolling faces is increased for each of the plurality of rows from the root of the trunnion toward the distal end of the trunnion," as recited in independent claim 1 (emphasis added).

Rather, Woolgar discloses an axle 1 having an end portion 3 which tapers regularly from a flange 2 to nearly the extremity of the end portion 3. (See Woolgar at page 1, lines 39-44) A cylindrical hub 6 is supported anti-frictionally on the end portion 3 to rotate about the axis of the latter by a rolling bearing supporting sleeve mounted on the end portion 3. The rolling bearing supporting sleeve consists of axially aligned end sections 7,8 disposed on the end portion 3. The bores of the sections 7,8 taper to complement the taper of the end portion 3 so that the sections 7,8 will closely fit the end portion 3. (See Woolgar at page 1, lines 58-76) Sections 7,8 are held against rotation on the end portion 3 by a locking key 25. (See Woolgar at page 2, lines 64-70)

Each of the sections 7,8 is formed with a plurality of circumferentially spaced grooves 12 in its outer periphery. Each groove 12 provides a seat in which a roller bearing 14 is rather

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loosely and rotatably supported. (See Woolgar at page 1, lines 104-110 and page 2, lines 1-9)

The roller bearings 14 protrude through openings 13 beyond the outer wall of sections 7,8.

The protruding portion of the roller bearings 14 are adapted to anti-frictionally support the hub 6 in spaced, concentric relation to the end portion 3. (See Woolgar at page 2, lines 20-35)

The Examiner asserts that the axle 1 corresponds to the trunnion of claims 18 and 19, and that outer peripheral face of the end portion 3 in Woolgar teaches a plurality of bearing rolling faces corresponding to a plurality of rows of rollers. However, as shown above, Woolgar clearly discloses that the bearings 14 are seated in grooves 12 on the outer periphery of sections 7,8. Given that the inner face of sections 7,8 complement the taper of end portion 3 and are closely fit to the end portion 3, the bearings 14 are not provided on the axle 1.

Thus, there are certainly no rolling faces provided on the axle 1.

Clearly, Woolgar does not teach or suggest "a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion," as recited in claims 18 and 19.

Further, there is no teaching or suggestion in Woolgar of the plurality of bearing rolling faces being reduced in diameter from a root of the trunnion toward a distal end of the trunnion, as in claims 18 and 19. The Examiner asserts that the outer peripheral face of the end portion 3 discloses such. However, as noted above, Woolgar fails to teach or suggest a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion. Thus, Woolgar clearly does not teach or suggest

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that each of the plurality of bearing rolling faces being reduced in diameter from a root of the trunnion toward a distal end of the trunnion.

Even assuming arguendo that the grooves in the end sections 7,8 teach a plurality of bearing rolling faces, there is no teaching or suggestion in Woolgar that the bearing rolling faces are reduced in diameter from a root of the trunnion to the distal end of the trunnion, as in claims 18 and 19. Rather, as noted above, Woolgar discloses that the bores of the sections 7,8 taper to complement the taper of the end portion 3 so that the sections 7,8 will closely fit the end portion 3. Therefore, the grooves 12 of sections 7,8 are not reduced in diameter.

Clearly, Woolgar does not teach or suggest "the plurality of bearing rolling faces being reduced in diameter from a root of the trunnion toward a distal end of the trunnion," as recited in claims 18 and 19.

Additionally, Woolgar does not teach or suggest that a radial clearance between the rollers and the rolling faces is increased for each of the plurality or rows from the root of the trunnion toward the distal end of the trunnion, as recited in claims 18 and 19. As noted above, Woolgar fails to teach or suggest a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion, or that each of the plurality of bearing rolling faces being reduced in diameter from a root of the trunnion toward a distal end of the trunnion.

In Woolgar, the bearings 14 are seated in the grooves 12 spaced around the outer periphery of sections 7,8. Further, sections 7,8 are formed of a resilient material, such as spring steel, and include slits 27,28, such that sections 7,8 are constricted radially upon assembly. Thereby, the inherent resiliency of the of the material of sections 7,8 will act to

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hold the roller bearings close against the inner wall of the hub 6. (See Woolgar at page 2, lines 74-95) Thus, even assuming arguendo that the grooves in the end sections 7,8 teach a plurality of bearing rolling faces, the inherent resiliency of the of the material of sections 7,8 will act to hold the roller bearings close against the inner wall of the hub 6. Therefore, the radial clearance between the bearing and the grooves would remain uniform.

Woolgar clearly does not teach or suggest that “a radial clearance between the rollers and the rolling faces is increased for each of the plurality or rows from the root of the trunnion toward the distal end of the trunnion,” as recited in claims 18 and 19.

In light of the above, Applicant submits that Woolgar does not teach or suggest each and every element of claims 18 and 19. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS & CONCLUSION

The Examiner has objected to the drawings. The Examiner alleges that the drawings failed to show various limitations of claims 1, 6, 15 and 20. Applicant submits that the amendments to claims 1, 15 and 20 address the Examiner’s objections regarding those claims. New Figure 8 is presented showing a roller including crownings as described in the Application on page 12, lines 1-7. No new matter has been added. The Examiner has further alleged that Figure 6 does not show the thrust bearing 7. However, Applicant submits that this objection is improper because the thrust bearing 7 is clearly shown in Figure 1.

The Examiner has objected to claim 18 based on an informality. Accordingly, claim 18 has been amended to correct the typographical error cited by the Examiner.

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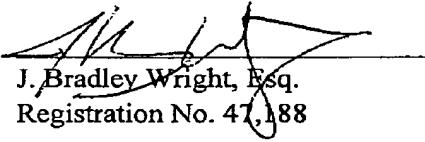
In view of the foregoing, Applicant submits that claims 1-20, all the claims presently pending in the application, are patentably distinct over the prior art of record and are allowable, and that the application is in condition for allowance. Such action would be appreciated.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned attorney at the local telephone number listed below to discuss any other changes deemed necessary for allowance in a telephonic or personal interview.

To the extent necessary, Applicant petitions for an extension of time under 37 CFR §1.136. The Commissioner is authorized to charge any deficiency in fees, including extension of time fees, or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 9/22/05


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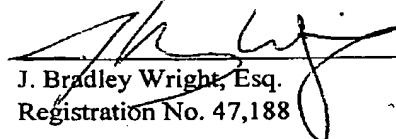
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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing Amendment and Drawing Corrections were filed by facsimile with the United States Patent and Trademark Office, Examiner Gregory John Binda, Group Art Unit #3679 at fax number (571) 273-8300 this 22nd day of September, 2005.



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